

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) In a steering control device equipped with: a turning mechanism including a turning actuator driving a position-controllable turning shaft; and a steering angle sensor detecting a steering angle θ of a steering wheel,

a steering control device comprises:

a turning displacement sensor detecting a turning displacement X ($-X_E \leq X \leq +X_E$) in said turning mechanism; and

means for calculating a turning instruction value calculating an instruction value for a turning displacement in said turning mechanism based on said steering angle θ ;

wherein:

said turning instruction value calculating means includes means for generating hysteresis characteristics calculating said instruction value X_n , ~~in exceptional situations where when an~~ absolute value $|\theta|$ of said steering angle θ exceeds a predetermined threshold value θ_E corresponding to an upper limit X_E of said turning displacement X , said instruction value X_n based on:

a vertical axis coordinate corresponding to said steering angle θ on a predetermined hysteresis loop with one side being a section of a line $X_n = \pm X_E$ on a θ - X_n plane; and

a steering direction (steering direction/restoring direction) of said steering wheel.

2. (Original) A steering control device as described in claim 1 wherein a steering mechanism including said steering wheel and said turning mechanism are mechanically separated, and an electrical coupling mechanism substitutes for a connecting mechanism connecting said steering mechanism and said turning mechanism.

3. (Original) A steering control device as described in claim 1 further comprising means for setting an endpoint setting a target coordinate for an endpoint P_O that closes said hysteresis loop.

4. (Original) A steering control device as described in claim 2 further comprising means for setting an endpoint setting a target coordinate for an endpoint P_O that closes said hysteresis loop.

10. (Original) A steering control device as described in claim 4 wherein, using a function $f(\theta)$ of said steering angle θ , symmetrical around the origin, and a correction gain G ($0 < G \leq 1$), said hysteresis loop on said θ - X_n plane is formed as a closed curve from said line $X_n = \pm X_E$, a curve $X_n = f(\theta)$, and a curve $X_n = Gf(\theta)$.

11. (Original) A steering control device as described in claim 5 wherein, using a function $f(\theta)$ of said steering angle θ , symmetrical around the origin, and a correction gain G ($0 < G \leq 1$), said hysteresis loop on said θ - X_n plane is formed as a closed curve from said line $X_n = \pm X_E$, a curve $X_n = f(\theta)$, and a curve $X_n = Gf(\theta)$.

12. (Original) A steering control device as described in claim 6 wherein, using a function $f(\theta)$ of said steering angle θ , symmetrical around the origin, and a correction gain G ($0 < G \leq 1$), said hysteresis loop on said θ - X_n plane is formed as a closed curve from said line $X_n = \pm X_E$, a curve $X_n = f(\theta)$, and a curve $X_n = Gf(\theta)$.

13. (Original) A steering control device as described in claim 7 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper limit X_E and said function $f(\theta)$.

14. (Original) A steering control device as described in claim 8 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper limit X_E and said function $f(\theta)$.

15. (Original) A steering control device as described in claim 9 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper limit X_E and said function $f(\theta)$.

16. (Original) A steering control device as described in claim 10 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper limit X_E and said function $f(\theta)$.

17. (Original) A steering control device as described in claim 11 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper

limit X_E and said function $f(\theta)$.

18. (Original) A steering control device as described in claim 12 further comprising means for calculating correction gain calculating a value for said correction gain G based on said upper limit X_E and said function $f(\theta)$.

19. (Original) A steering control device as described in claim 7 further comprising means for asymptote normalization monotonically increasing said correction gain G ($0 < G \leq 1$) in a dynamic manner based on a steering amount S , a steering status, a turning amount Z , or a turning status after initiation of restorative steering having as a starting point said line $X_n = \pm X_E$.

20. (Original) A steering control device as described in claim 13 further comprising means for asymptote normalization monotonically increasing said correction gain G ($0 < G \leq 1$) in a dynamic manner based on a steering amount S , a steering status, a turning amount Z , or a turning status after initiation of restorative steering having as a starting point said line $X_n = \pm X_E$.

21. (Original) A steering control device as described in claim 19 wherein said asymptote normalizing means includes means for varying an asymptote rate using a steering velocity ω ($= d\theta/dt$), a steering torque τ , said steering angle θ , said steering direction, or an automobile velocity v , in order to dynamically change an asymptote rate A ($\equiv dG/dS$) for said steering amount S of said correction gain G or an asymptote rate B ($\equiv dG/dZ$) for said turning amount Z of said correction gain G when said correction gain G ($0 < G \leq 1$) is being monotonically increased in a dynamic manner.

22. (Original) A steering control device as described in claim 20 wherein said asymptote normalizing means includes means for varying an asymptote rate using a steering velocity ω ($= d\theta/dt$), a steering torque τ , said steering angle θ , said steering direction, or an automobile velocity v , in order to dynamically change an asymptote rate A ($\equiv dG/dS$) for said steering amount S of said correction gain G or an asymptote rate B ($\equiv dG/dZ$) for said turning amount Z of said correction

gain G when said correction gain G ($0 < G \leq 1$) is being monotonically increased in a dynamic manner.

23. (Original) A steering control device as described in claim 1 further comprising means for varying a steering angle threshold dynamically changing upper and lower limits of a predetermined tolerance range ($-\theta_E \leq \theta \leq \theta_E$) of said steering angle θ based on an automobile velocity v .

24. (Original) A steering control device as described in claim 2 further comprising means for varying a steering angle threshold dynamically changing upper and lower limits of a predetermined tolerance range ($-\theta_E \leq \theta \leq \theta_E$) of said steering angle θ based on an automobile velocity v .

25. (Original) A steering control device as described in claim 3 further comprising means for varying a steering angle threshold dynamically changing upper and lower limits of a predetermined tolerance range ($-\theta_E \leq \theta \leq \theta_E$) of said steering angle θ based on an automobile velocity v .

26. (Original) A steering control device as described in claim 5 further comprising means for varying a steering angle threshold dynamically changing upper and lower limits of a predetermined tolerance range ($-\theta_E \leq \theta \leq \theta_E$) of said steering angle θ based on an automobile velocity v .

27. (Original) A steering control device as described in claim 7 further comprising means for varying a steering angle threshold dynamically changing upper and lower limits of a predetermined tolerance range ($-\theta_E \leq \theta \leq \theta_E$) of said steering angle θ based on an automobile velocity v .

28. (Original) A steering control device as described in claim 13 further comprising means

mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

34. (Original) A steering control device as described claim 5 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

35. (Original) A steering control device as described claim 7 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

36. (Original) A steering control device as described claim 13 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

37. (Original) A steering control device as described claim 19 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper

limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

38. (Original) A steering control device as described claim 22 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .

39. (Original) A steering control device as described claim 23 wherein said steering mechanism includes means for generating endpoint reactions generating, at a vicinity of an upper limit position θ_E of said steering angle θ and at a vicinity of a lower limit position $-\theta_E$ of said steering angle θ , a virtual abutment resistance restricting said steering angle θ from exceeding a predetermined tolerance range $(-\theta_R \leq \theta \leq \theta_E)$, based on said steering angle θ , said turning displacement X , or an instruction value X_n for said turning displacement X .